Buyback Programs And Industry Restructuring in Fisheries

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Abstract: NOAA Fisheries has conducted several buyback programs to reduce harvesting capacity in fisheries. These programs have attempted to maximize capacity reduction given a fixed budget. However, restructuring issues have not been considered. In this paper, we explore the possibility of satisfying three different buyback objectives. We examine the south Atlantic black sea bass trap fishery, and estimate the number of vessels given different allowable catch levels, and the objectives of maximizing technical efficiency, capacity utilization, and the number of vessels in the fishery. We then link cost considerations with these objectives. Results show considerable variability in both the number of vessels allowed to remain in the fishery, and in the cost of buying out capacity.

Introduction

Excess capacity in fisheries is a global issue. NOAA Fisheries, the Food and Agriculture Organization (FAO) of the United Nations, and various member nations have all initiated plans to both measure capacity, and identify methods to reduce excess capacity. In the United States, several fishing vessel buyback programs have occurred. The primary objective of these initiatives was to reduce capacity as much as possible given the fixed amount of funds available for the buyback. Objectives such as whether the reduction should yield the most technically efficient fleet or a fleet consistent with maximum capacity utilization or some alternative were not considered. However, the United States General Accounting Office (GAO) has considered these buyouts as being only marginally successful (GAO, 2000). One major problem recognized by the GAO was that the buyback programs did not restrict individuals from returning to the same fishery or entering other fisheries.

In 2002, NOAA Fisheries prepared a report on overcapacity (as opposed to excess capacity) in five federally managed fisheries and estimated the cost of eliminating overcapacity (Kirkley et al., 2002). Overcapacity exists when capacity levels are not aligned with long term resource goals. The five fisheries examined were the New England and West Coast groundfish fisheries, the Atlantic large coastal pelagic shark fishery, the Gulf of Mexico shrimp fishery, and the Atlantic swordfish fishery. All of these fisheries possess substantial excess capacity and overcapacity; the total cost of eliminating this overcapacity was estimated to be nearly $1.0 billion.

In this paper, we present results of an analysis of a buyback program for the South Atlantic black sea bass trap fishery. The objectives of the buyout included: (1) maximizing technical efficiency, by reducing capacity such that technical efficiency is maximized subject to various total allowable catch (TAC) levels; (2) maximizing capacity utilization by reducing capacity such that the existing capital stock of the fleet is fully utilized subject to various TAC levels; and (3) maximizing the fleet size to harvest the desired sustainable yield or TACs. The third objective is the most undesirable objective relative to economic concerns, but it is one often under considered by management councils. For each of these three objectives, the cost of buying vessels is compared to a buyout scheme where vessels are ranked by the ratio of bid price to capacity, and then purchased until the capacity of the remaining fleet is below the TAC. We find that depending upon the stated objective, the number of vessels remaining in the fishery varies substantially, and one strategy is clearly dominant with regards to cost.

Data

Data on vessel characteristics, such as vessel length and engine horsepower, were obtained from the permits database at the NOAA Fisheries Southeast Regional Office. Landings data, along with gear type and amount of gear deployed, were obtained from trip reports in the logbook database at the Southeast Fisheries Science Center, and from weighout files. Our analyses assumed that the vessel characteristics, gear type, number of gear, and hours fished were fixed, and considered fixed factors of production. By assuming that the quantity of gear and hours fished per trap (i.e. soak time) were fixed, we were able to estimate capacity given customary and usual operating procedures (CUOP). Data on days at sea and crew size per trip were considered variable factors of production (i.e., these factors can be easily changed by the vessel operator, but only within certain bounds). The data covered fishing operations occurring between 1995 and 2001 (Table 1).

After reviewing the data, we decided to examine capacity only for the trap/pot fishery for black sea bass. This is the primary fishery harvesting black sea bass and had the fewest number of observations with missing information. There were 370 vessels which reported landing some sea bass in 1995, with 75 vessels reporting landing some sea bass in the trap fishery. However, of the 75 vessels participating in the trap fishery in 1995, only 54 vessels had information that could be used to estimate capacity. Landings by trap gear for vessels having complete information accounted for approximately 60 to 73 percent of the total landings between 1995 and 2001.

Methods

We used data envelopment analysis (DEA) to estimate capacity. DEA is a non-parametric, mathematical programming approach, which has been used to estimate technical efficiency of production. Charnes et al. (1978) initially developed DEA, and F@re (1984) proposed DEA as a method for estimating capacity, and offered a framework for determining the required level of variable inputs (e.g., labor and days at sea) to produce capacity output. A comprehensive introduction to using DEA to estimate capacity in fisheries is provided F@re et al. (2000).

Two basic black sea bass fisheries were initially considered. The first was a single species fishery (i.e., trips in which only black sea bass was reported as being landed). The second fishery was a multi-species fishery, but restricted to two categories—black sea bass and all other species. There were a total of 6,529 trips during which black sea bass were landed by trap gear between 1995 and 2001. Of this total, 1,732 trips landed only black sea bass, and 4,797 trips landed black sea bass and some other species. Each fishery was further disaggregated into five clusters. Cluster analysis is a non-parametric method for grouping similar observations (Kaufman and Rousseeuw, 1990). Clustering was done to reduce the possibility of over-estimating capacity, which might occur if capacity estimates for all trips were determined primarily by highliners or lucky catches. Estimates of capacity output should be viewed as lower bound estimates. This is because the estimates were based on only one fleet—the trap fishery; data were incomplete even relative to the trap fishery and some inputs, assumed to be fixed, (number of traps and hauls and time fished) could actually be changed by vessel operators.

Analytical Results

Capacity was estimated using DEA for all years and clusters, requiring ten separate estimations. Trip-level estimates were then summed over individual vessels and years, and subsequently, total fleet activity was summarized by year, over all observations (Table 2). We again stress that our estimates of capacity output represent lower bound values. In general, vessels had the capability to harvest two times the level they actually harvested between 1995 and 2001 (Table 3). Mean days at sea per year per vessel during 1997-2001 would have only had to marginally increase (by about 12%) to realize the capacity output . The average level of landings per vessel peaked in 1999, when vessels averaged 7,084 pounds of black sea bass per vessel. Mean capacity output was highest in 2001, when it was estimated to equal 15,361 pounds per vessel. Of the 51 vessels operating in 2001, eight vessels (15.7 %) had black sea bass landings higher than 15,361 pounds. These eight vessels averaged 66.6 days away from port in 2001. In contrast, 43 vessels in 2001 landed less than the estimated capacity output of 15,361 pounds. They landed, on average, 3,690 pounds per vessel, and accounted for a total of 158,667 pounds or 44 percent of the total black sea bass trap landings in 2001 (360,825 pounds). The average engine size was 434 horsepower; the average length per vessel was 36 feet; the average days at sea per year equaled 13.02; and the average crew size was 1.84.

Industry Restructuring

In previous buyback programs (i.e., Northeast groundfish), the goal has been to buy as much capacity as possible given a fixed budget. However, little attention has been paid to the potential reconfiguration of a fleet after a buyback. Capacity reduction programs may result in one of several outcomes, such as increased technical inefficiency, or lower capacity utilization. No Fishery Management Council has explicitly identified a preferred desire for a post-buyout fleet structure. For example, is the goal to have a few vessels fishing virtually year-round, or a larger part-time fleet which also has the ability to exploit opportunities in other fisheries?

We examine three possible objectives of a buyback program: (1) maximization of technical efficiency, (2) maximization of capacity utilization, and (3) maximization of the number of vessels in the fishery. For comparative purposes, we also consider a capacity reduction program that removes vessels based on the ratio of bid price to capacity. We also consider six different total allowable catch (TAC) levels because the South Atlantic Fisheries Management Council has not yet established an overall TAC for the black sea bass fishery. We initially estimate the number of vessels needed to harvest each TAC, assuming that each vessel lands either the mean capacity level or the median capacity level (Table 4). The next analysis considers the number of vessels required to harvest each TAC, assuming an objective of maximum technical efficiency for the fleet (Table 5). This was accomplished by using annual estimates of vessel capacity averaged over the 1995-2001 period, and ranking technical efficiency scores from 1.0 (the most efficient) to higher values (the least efficient). We also estimate the number of vessels needed to harvest each TAC, assuming an objective of maximizing capacity utilization (Table 6). To do this, we ranked CU scores were ranked from 1.0 (full capacity output) to lower values (lowest capacity utilization). Finally, to assess the maximum number of vessels that can remain in the fleet and harvest the TAC, capacity output levels were ranked from lowest to highest, and then cumulatively summed up to the TAC (Table 7).

There were 151 active black sea bass trap vessels during the time period 1995-2001. If management desired to reduce capacity, assuming mean capacity over all vessels, and a 250.0 thousand pound TAC, the resulting maximum fleet size would be 19 vessels (Table 4). If managers desired to match the median capacity to the TAC, the maximum fleet size would be 52 vessels. Alternatively, if the buyout objective was to promote technical efficiency and match capacity to a TAC of 250 thousand pounds, the maximum fleet size would be 47 vessels (Table 5). In this case, however, management would need to explicitly target the vessels to remain in the fishery. If the buyout objective was to maximize capacity utilization, a fleet size of 34 vessels would be required to harvest a 250,000 pound TAC (Table 7). Again, management would have to explicitly identify those vessels to remain in the fishery. If the buyout objective was to maximize the number of vessels in the fleet needed to harvest a TAC of 250 thousand pounds, the fleet would be as large as 81 vessels (Table 7).

A TAC of 1.5 million pounds and vessels operating at the overall mean annual capacity would require an approximate fleet size of about 113 vessels. If the buyout objective was to maximize either technical efficiency or capacity utilization, the fleet size, respectively, could be as high as 102 (Table 6) or 100 vessels (Table 7). A TAC of 1.5 million pounds, however, is more than three times the level of landings reported in any year between 1995 and 2001.

Although it might be anticipated that ranking by technical efficiency would result in the least number of vessels, this is not the case for this fishery. There is no apparent pattern of technical efficiency relative to size. For example, the engine horsepower required to maximize efficiency for the 47 vessels, given a TAC of 250,000 pounds, ranges from 80 to 671; vessel lengths range between18 and 68 feet. In essence, small vessels can be as efficient as larger vessels. The same reasoning applies to determining the number of vessels necessary to maximize capacity utilization. Simply, it is possible for many small vessels to more fully utilize their productive capacity than can the large vessels, and thus, a larger number of vessels may be allowed to remain in the fishery for a given TAC.

In recent years, management has tended to promulgate regulations that either address issues related to full-time operators or to promote full-time operations. If a buyback program was designed to primarily eliminate the part-time operators in this fishery, the required number of vessels remaining in the fishery could be extremely low. Using days at sea as an indicator of fishing activity, and sorting from highest capacity to lowest, yields the following required number of vessels to harvest various TAC levels: (1) one vessel for a TAC of 250 thousand pounds; (2) two vessels for a TAC of 500 thousand pounds; (3) three vessels for a TAC of 750 thousand pounds; (4) five vessels for a TAC of 1 million pounds; (5) seven vessels for a TAC of 1.25 millions pounds; and (6) 10 vessels for a TAC of 1.5 million pounds.

Results clearly showed differing fleet sizes based on the desired structure of the post-buyout fleet. However, the cost of the various buyout options has not yet been examined. To incorporate buyout cost, we assumed that the bid price for a vessel would be equal to a year's revenue by the vessel from all species. This assumption approximated what occurred in vessel buyouts in the northeast region. Average annual revenue (nominal dollars) for the period 1995-2001 for each vessel was considered a proxy for yearly revenue. The three buyout strategies were compared to one that ranked vessels using the ratio of average revenue to capacity, from lowest to highest, and then selected vessels until the TAC was reached.

The strategy of ranking vessels based on revenue to capacity was clearly the least costly buyout strategy (Figure 1), and also the least costly in terms of dollars per unit capacity purchased (Figure 2). Maximizing the capacity utilization (CU) of the remaining fleet was the most costly in terms of total cost and dollars per unit capacity purchased. Maximizing technical efficiency (TE) of the remaining fleet was less costly than either maximizing CU or maximizing fleet size, but inferior to ranking vessels based on the revenue to capacity ratio. Maximizing fleet size tended to be more costly in dollar terms because the vessels that need to be purchased generally were the higher capacity vessels, which had higher revenues associated with their capacity. Finally, the technical efficiency of the remaining vessels was examined (Figure 3). Maximizing the TE of the remaining fleet resulted in a more efficient mix of vessels than any of the other strategies. This result was not surprising given the specific objective was to have the most technically efficient fleet given each of the TAC goals. The strategy of maximizing fleet size resulted in the highest TE score at any TAC level. Clearly, the goals of maximizing fleet size and maximizing CU result in a more inefficient fleet at a higher cost to the taxpayer.

Summary and Conclusions

NOAA Fisheries is concerned about harvesting capacity in US fisheries, as excess capacity typically equates to economic waste and the potential for biological overfishing. NOAA Fisheries, the U.N. Food and Agricultural Organization, and various agencies of numerous foreign nations are seeking ways to measure capacity and reduce excess capacity in fisheries. One way of reducing capacity is via buyback programs. At the present time, the principal objective typically pursued in conducting buyback programs is to reduce capacity as much as possible given a fixed budget for purchasing vessels.

In this paper, we estimated capacity and the subsequent restructuring of a fleet given different buyback program objectives. We selected the black sea bass trap fishery because it is one of the less complex fisheries of the United States, but still has many of the problems occurring in other fisheries. The analysis was based on data envelopment analysis or DEA, a mathematical programming approach that determines technical efficiency and capacity.

Excess capacity in this fishery in all years between 1995 and 2001, with the fleet having the capability to harvest approximately 2.1 times the level of reported landings. The primary reason the vessels did not operate at full capacity appears is related to technical inefficiency. The required increase in the number of days to operate at full capacity was quite small relative to the reported number of days vessels actually operated in each year.

The results, however, reflect lower bound estimates of capacity output in the black sea bass fishery. Because there was inadequate data on vessel characteristics and variable input usage, it was not possible to estimate capacity output for all vessels landing sea bass between 1995 and 2001. Secondly, the estimates of capacity output pertain only to a subsection of the trap fishery, again, due to data limitations. Third, some of the input or productive factors, which were assumed to be fixed factors of production, can be changed by vessel operators (e.g., number of traps and hauls and time fished). It would be expected that increasing the number of traps would increase the productive capacity of vessel operations.

A key remaining issue is what are the goals and objectives of any capacity reduction program. NOAA Fisheries and the Councils have not provided clear goals other than ensuring that capacity cannot exceed desired sustainable levels, and a buyback program should attempt to remove as much capacity as is possible subject to a fixed budget. For example, the capacity of a fleet should be less than or equal to a level to ensure that landings cannot exceed the maximum sustainable yield or some other biological target, and as much capacity, as possible, should be reduced given the budget. However, different goals and objectives can result in different fleet configurations and number of vessels remaining in the fishery. For example, if resource managers decided on a TAC of 250 thousand pounds for the trap fishery and used the overall mean capacity output per vessel, a fleet size of 19 would be appropriate. If maximization of TE was the objective, a TAC of 250 thousand pounds would require only 47 vessels in the fishery. Alternatively, if managers desired to maximize CU, a TAC of 250 thousand pounds would imply a fleet size of 34 vessels. An objective that maximized the number of vessels in the fishery would allow 81 vessels to remain the fishery, given a TAC of 250 thousand pounds. Lastly, if management desired to reduce capacity such that only full-time vessels were involved in the fishery, a single vessel could harvest a TAC of 250 thousand pounds. Given such wide differences in the number of vessels and the associated differences in technical efficiency and capacity utiliation, it is, thus, extremely important to clearly articulate the goals and objectives of capacity reduction programs. These goals should also consider the cost of potential industry restructuring. Different strategies have very different costs, which need to be considered in any vessel buyout.

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Table 1. Vessel Characteristics, Landings and Effort in the Black Sea Trap Fishery 1995-2001.

	Year						
	1995	1996	1997	1998	1999	2000	2001
Number of Vessels in Fishery	370	339	357	339	310	260	243
Number of Trap Vessels	75	80	93	77	72	68	57
Vessels in Capacity Estimate	54	73	81	71	65	61	51
Trips	999	1,153	1,330	1,199	1,050	828	1,070
Horsepower							
Minimum	130	40	115	120	120	120	175
Mean	310	320	333	348	355	342	360
Median	280	275	300	300	318	300	315
Max	671	800	800	800	735	735	650
Vessel Length							
Minimum	21	22	20	18	18	24	24
Mean	34	38	38	36	35	35	36
Median	34	34	34	35	35	34	35
Max	48	50	50	68	48	50	50
Crew Size per Trip							
Minimum	1	1	1	1	1	1	1
Mean	1.7	1.9	1.8	1.9	1.8	1.9	2
Median	1.9	2.0	1.67	2.0	2.0	2.0	2
Max	3	3	4	4	3	3	3
Days Absent per Year							
Minimum	1	1	1	1	1	1	1
Mean	17.4	18.5	18.1	18.6	17.2	13.5	21
Median	11.0	10.0	7.0	8.0	8.0	7.0	13
Max	85	92	131	107	94	69	149
Hauls per Trip							
Minimum	2	1	1	1	1	1	1
Mean	52	52	40	48	46	47	60
Median	42	31	25	33	26	21	32
Max	217	367	270	370	529	638	720
Traps per Trip							
Minimum	2	2	2	1	2	2	3
Mean	27	24	25	26	28	25	30
Median	22	20	23	21	22	20	23

Max	100	151	150	101	118	120	117
Yearly Landings of Black Sea Bass							
Minimum	3	69	21	36	70	30	55
Mean	5,533	6,343	6,095	6,594	7,084	5,470	7,075
Median	3,637	3,466	2,227	1,870	2,938	2,126	3,308
Max	34,565	48,417	57,046	47,282	44,526	30,715	43,166
Landings of Other Species							
Minimum	0	0	0	0	0	0	0
Mean	1,219	958	1,105	780	920	876	1,189
Median	526	130	174	112	173	107	253
Max	15,569	17,057	16,385	10,917	11,458	12,325	13,139

Table 2. Estimates of Capacity, Capacity Utilization and Full Variable Input Utilization, 1995-2001

	Year						
	1995	1996	1997	1998	1999	2000	2001
Capacity Utilization							
Minimum	0.75	0.55	0.68	0.77	0.41	0.57	0.76
Mean	0.96	0.96	0.95	0.96	0.94	0.95	0.95
Max	1	1	1	1	1	1	1
Potential Capacity Output							
Minimum	3	90	142	123	127	108	55
Mean	11,803	12,413	13,138	14,767	14,361	10,987	15,361
Max	83,056	102,370	137,456	114,907	93,495	72,472	121,358
Sum	637,386	906,182	1,064,153	1,048,482	933,444	670,184	783,399
Potential Capacity Output of Other Species							
Minimum	0	0	0	0	0	0	0
Mean	1,219	1,996	2,547	2,013	2,132	1,965	3,009
Max	15,569	26,124	37,894	22,776	21,846	23,711	29,201
Sum	149,110	145,727	89,517	142,908	138,566	119,858	153,447
Required Crew Size to produce capacity output							
Minimum	1	1	1	1	1	1	1
Mean	1.57	1.68	1.61	1.59	1.59	1.63	2
Max	2.47	3	2.25	2.21	2.25	2	3
Days Required to Produce Capacity Output							
Minimum	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Mean	17.3	17.3	20.6	19.6	19.0	15.7	24.0
Max	86.0	86.0	131.0	129.0	112.0	89.0	197.0

Table 3. Average and Optimal Values from the DEA Analysis

	Year						
	1995	1996	1997	1998	1999	2000	2001
Crew Size per Trip							
Average	1.7	1.9	1.8	1.9	1.8	1.9	2
Optimal	1.6	1.7	1.6	1.6	1.6	1.6	2.0
Days Absent per Year							
Average	17.4	18.5	18.1	18.6	17.2	13.5	21
Optimal	17.3	17.3	20.6	19.6	19.0	15.7	24.0
Yearly Landings of Black Sea Bass							
Average	5,533	6,343	6,095	6,594	7,084	5,470	7,075
Capacity Output	11,803	12,413	13,138	14,767	14,361	10,987	15,361
Capacity Output/Actual	2.1	2.0	2.2	2.2	2.0	2.0	2.2
Landings of Other Species							
Average	1,219	958	1,105	780	920	876	1,189
Capacity Output	2,761	1,996	2,547	2,013	2,132	1,965	3,009
Capacity Output/Actual	2.3	2.1	2.3	2.6	1.0	2.2	2.5

Table 4. Number of Vessels Required to Harvest TAC Given Vessels Operate

At Either Mean or Median Capacity Levels

Potential Total Allowable Catch	Number of Vessels to Harvest TAC, Given 1995-2001 Mean Capacity Output (13,253 Pounds) Per Year Per Vessel	Number of Vessels to Harvest TAC, Given 1995-2001 Median Capacity Output (4,853 Pounds) Per Year Per Vessel
250,000	19	52
500,000	38	103
750,000	57	155
1,000,000	75	206
1,250,000	94	258
1,500,000	113	309

Table 5. Number of Vessels Required to Harvest TAC Given the Objective of Maximizing Technical Efficiency (TE)

TAC	Number Of Vessels[a]	Mean Capacity Utilization	Mean Technical Efficiency	Capacity Utilization Reported Divided By Capacity Landings
250,000	47	0.91	1.94	0.59
500,000	57	0.91	2.20	0.54
750,000	72	0.91	2.61	0.49
1,000,000	79	0.91	2.81	0.47
1,250,000	87	0.90	3.04	0.44
1,500,000	102	0.90	3.56	0.40

[a]Average annual efficiency scores sorted from 1.0 (most technically efficient) to higher values (least technically efficient) and capacity output cumulatively summed until it approximately equals the TAC.

Table 6. Number of Vessels Required to Harvest TAC Given the Objective of Maximizing Capacity Utilization

TAC	Number Of Vessels[a]	Mean Capacity Utilization	Mean Technical Efficiency	Capacity Utilization Reported Divided By Capacity Landings
250,000	34	1.00	4.92	0.46
500,000	43	0.99	5.43	0.42
750,000	64	0.98	5.17	0.41
1,000,000	83	0.97	5.78	0.39
1,250,000	91	0.96	5.94	0.38
1,500,000	100	0.95	6.04	0.36

[a]Average annual capacity utilization sorted from 1.0 (highest capacity utilization) to lower values (minimum capacity utilization) and capacity output cumulatively summed until it approximately equaled the TAC.

[b]Capacity utilization may be calculated using either the ratio of technically efficient output to capacity output or the ratio of reported (actual) output to capacity output. F@re et al. (1989) demonstrated that capacity utilization should actually be calculated using the ratio of technically efficient output to capacity output. The Federal Reserve and other government agencies, however, often use the ratio of observed or actual output to capacity output as a measure of capacity utilization. This column reports the latter concept of CU—observed or actual landings divided by the capacity output.

Table 7. Number of Vessels Required to Harvest TAC Given the Objective of Maximizing the Number of Vessels in the Fishery

TAC	Number Of Vessels	Mean Capacity Utilization	Mean Technical Efficiency	Capacity Utilization Reported Divided By Capacity Landings
250,000	81	0.91	5.02	0.40
500,000	101	0.91	5.42	0.37
750,000	113	0.91	5.73	0.35
1,000,000	122	0.90	6.06	0.34
1,250,000	130	0.90	6.06	0.33
1,500,000	135	0.90	6.12	0.33

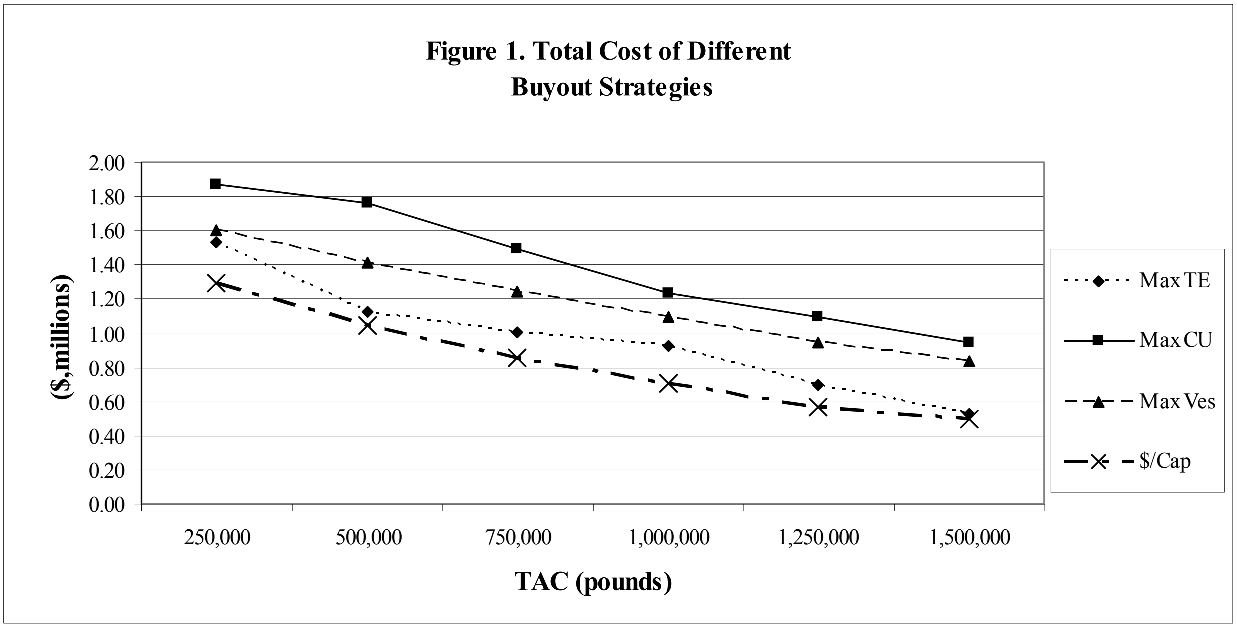
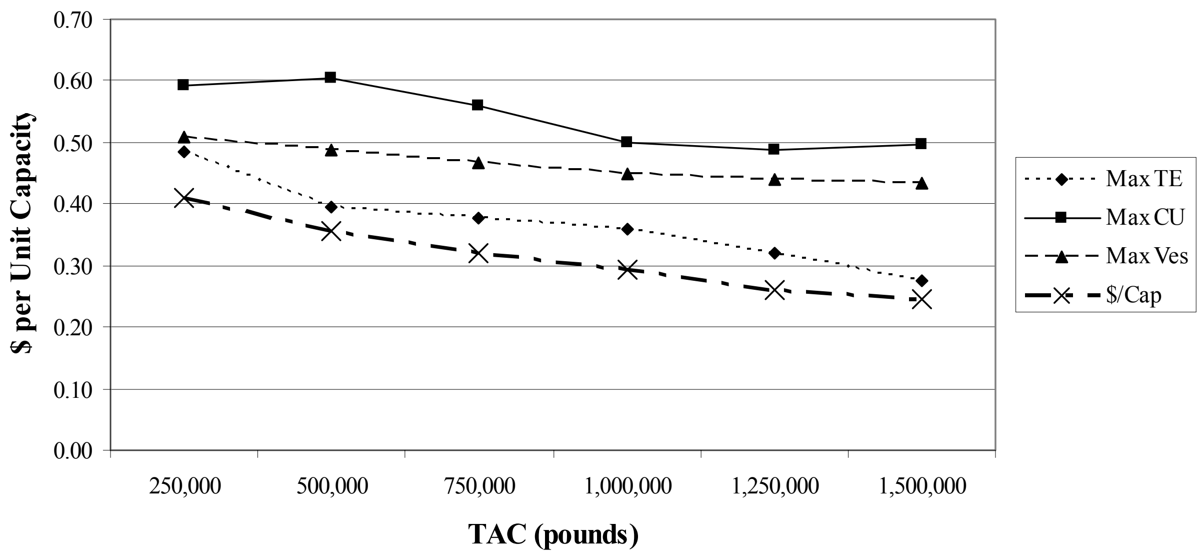


Figure 1. Total Cost of Different
Buyout Strategies
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
($,millions)
250,000
500,000
750,000
1,000,000
1,250,000
1,500,000
TAC (pounds)
Max TE
Max CU
Max Ves
$/Cap

Figure 2. Cost per Unit Capacity of Different Buyout Strategies



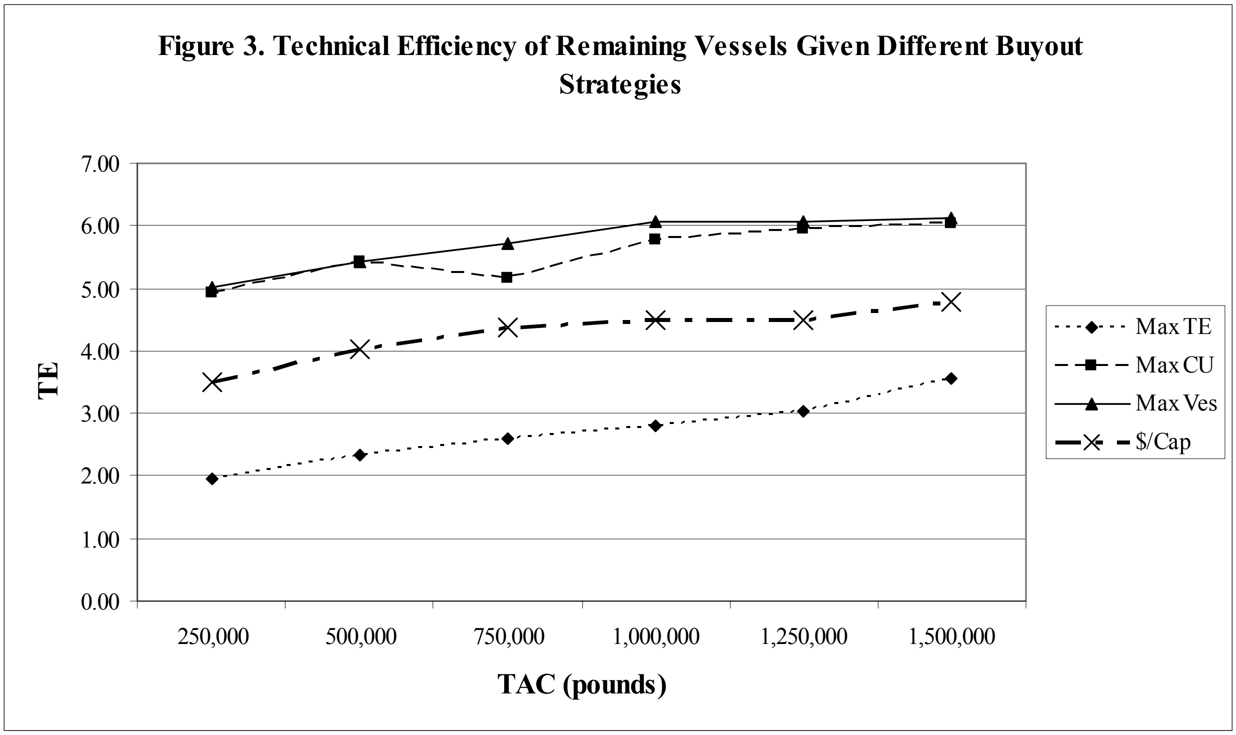


Figure 3. Technical Efficiency of Remaining Vessels Given Different Buyout Strategies
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
TE
250,000
500,000
750,000
1,000,000
1,250,000
1,500,000
TAC (pounds)
Max TE
Max CU
Max Ves
$/Cap